



Use of geodetic observations for regional monitoring of vertical land motion along Eastern Seaboard United States

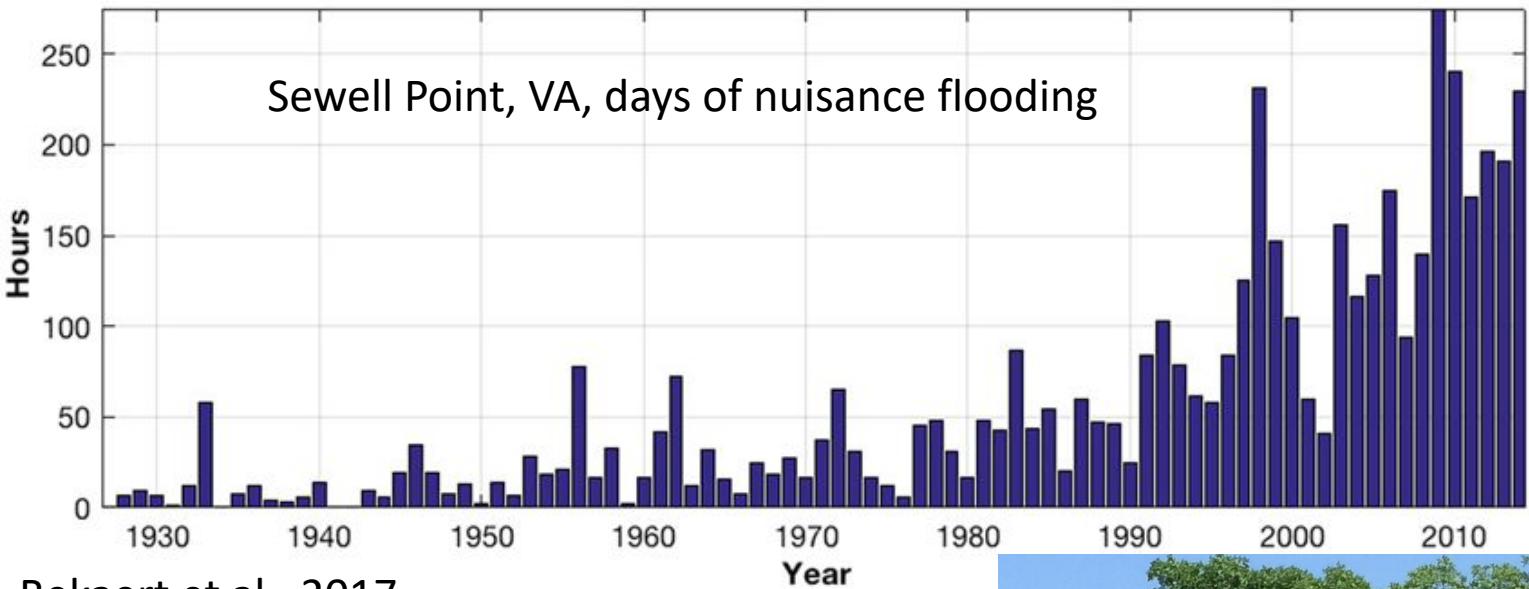
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East Coast of United States has high susceptibility to flooding:



Bekaert et al., 2017



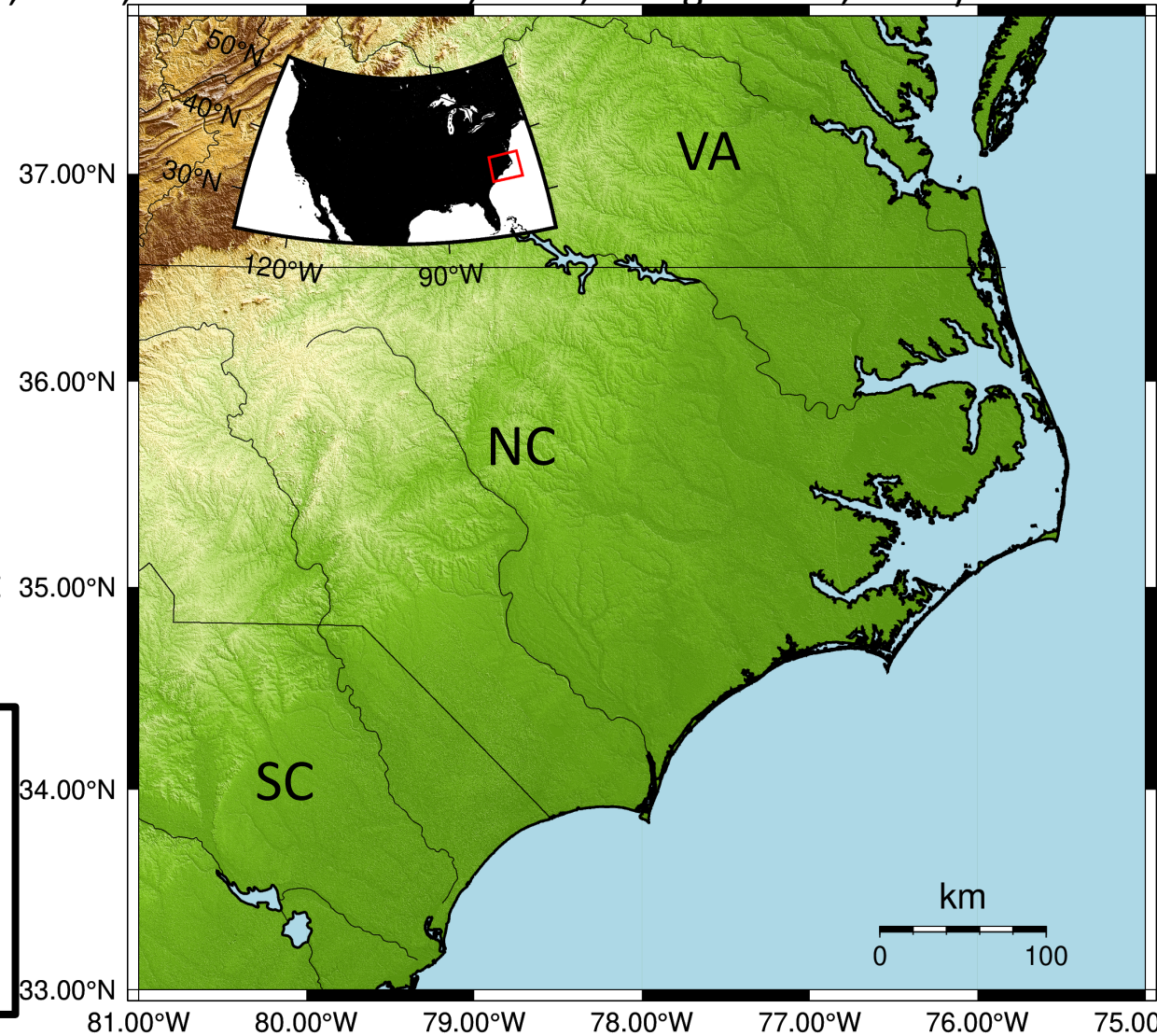
East Coast of United States has high susceptibility to flooding:

- The combined effects of sea-level rise and land subsidence need to be considered in long-term flood mitigation and planning (Dixon et al., 2006; Ezer and Atkinson, 2014, Karegar et al., 2016)

Causes of Subsidence:

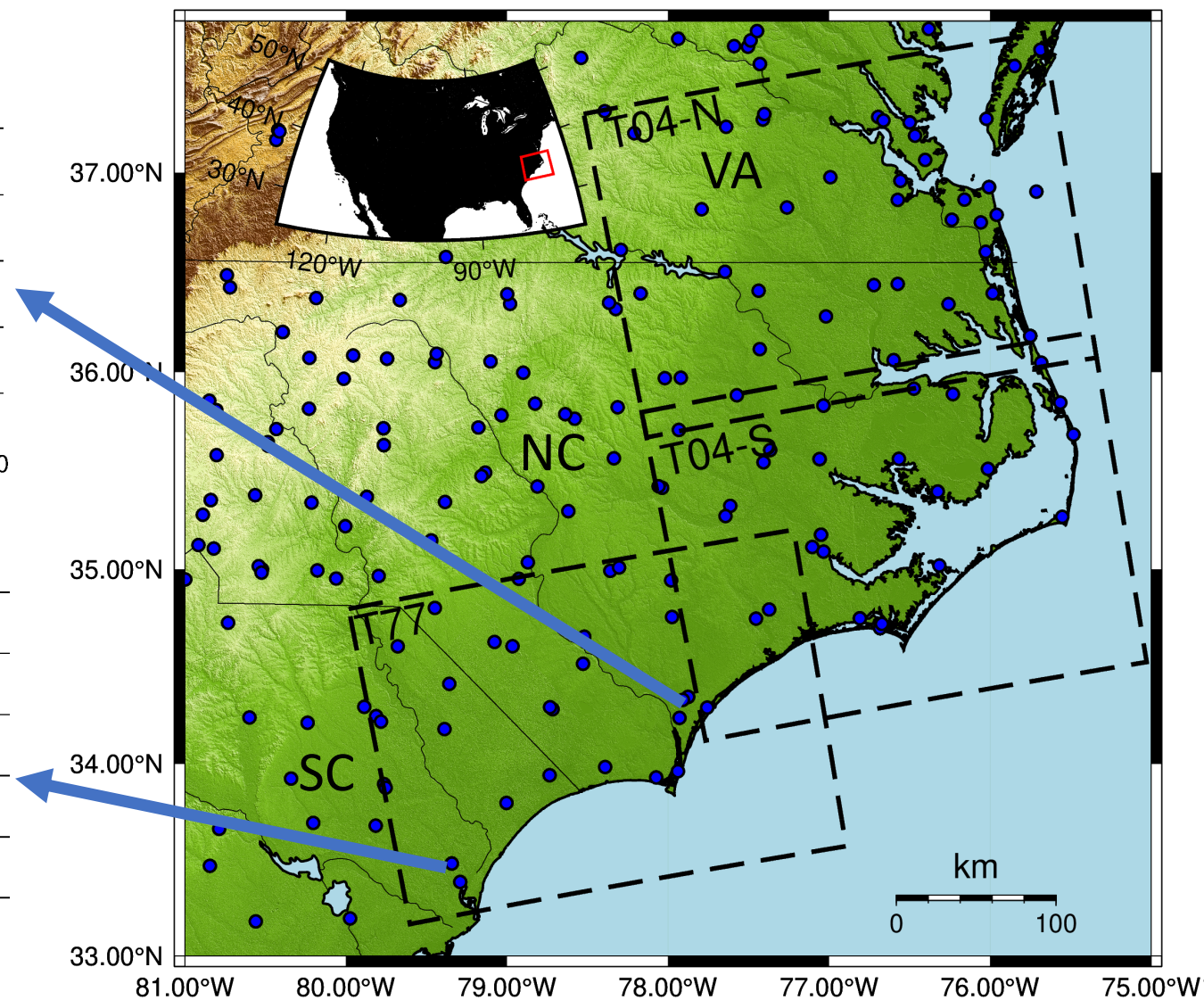
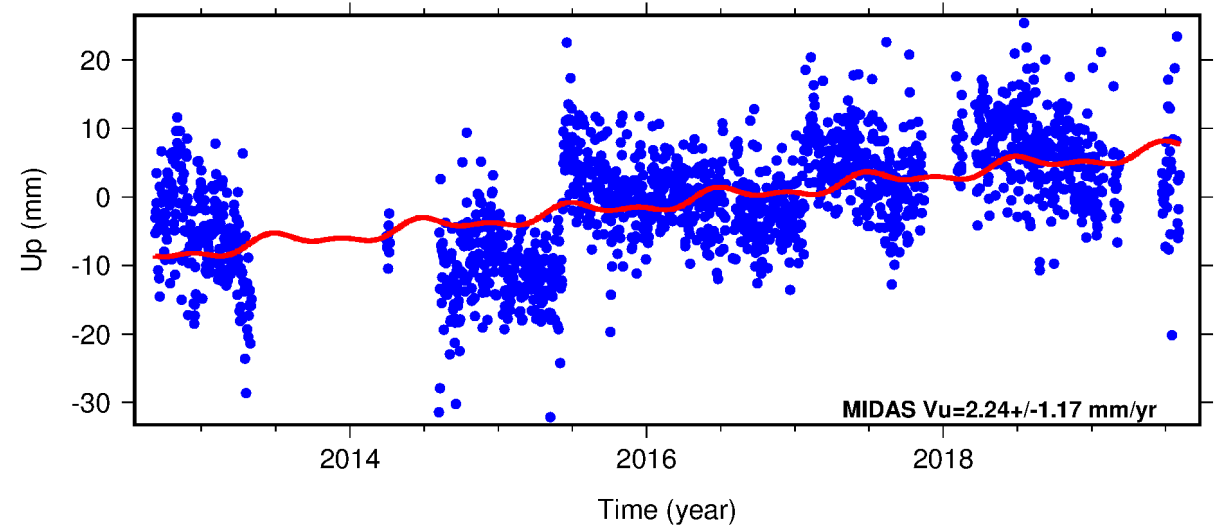
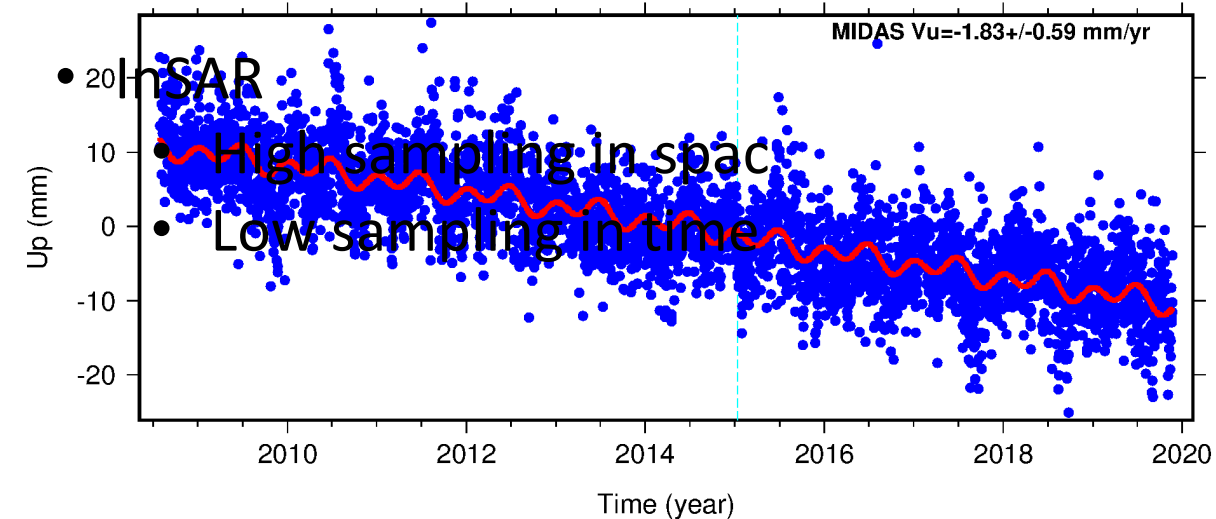
- Global Isostatic Adjustment (GIA) is the dominant driver of vertical motion.
- Groundwater withdrawal and recharge (e.g. Depaul et. al., 2008; Boon et al., 2010)
- Sediment loading and compaction (e.g. Calais et al., 2010; Miller et al., 2013)

Geodetic observations can provide high resolution information on short wavelength signals which can contribute to relative sea level rise.



Geodetic observations compliment each other :

- cGNSS
 - High sampling in time
 - Low sampling in space

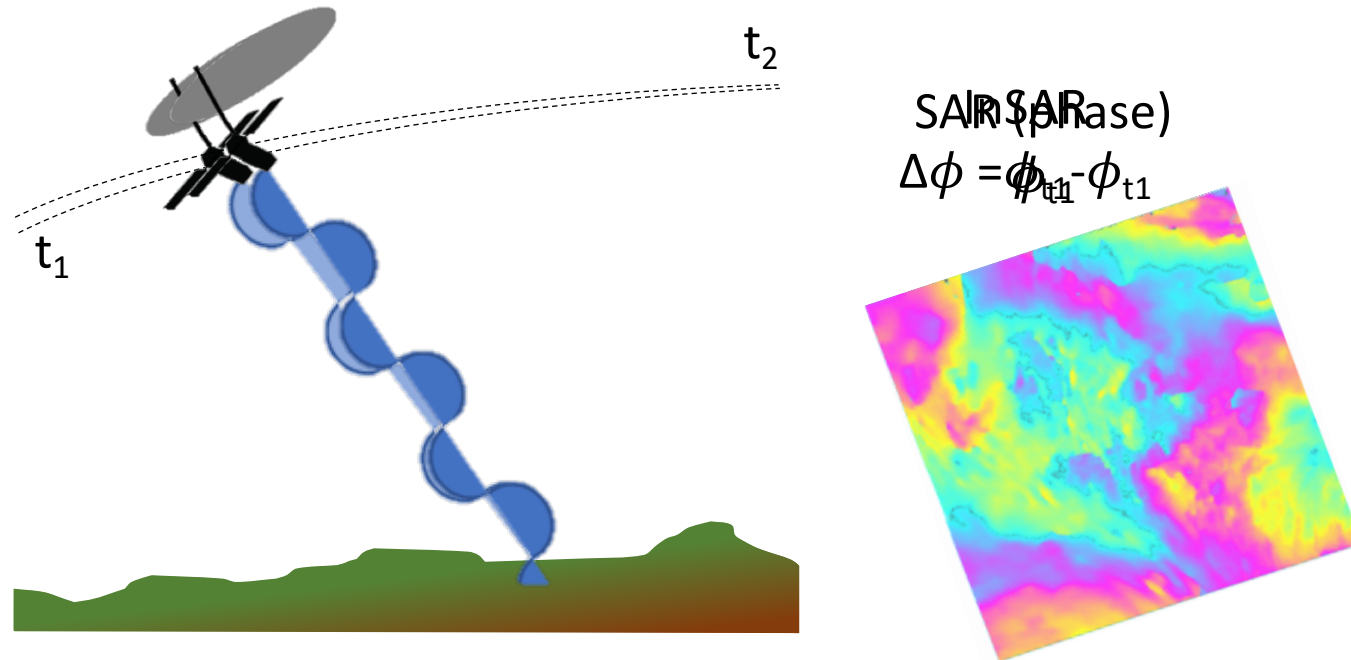


How does InSAR work:

- Capable of detecting changes on the surface with mm precision.
- Can achieve spatial resolutions of 30m and better when targets remain coherent

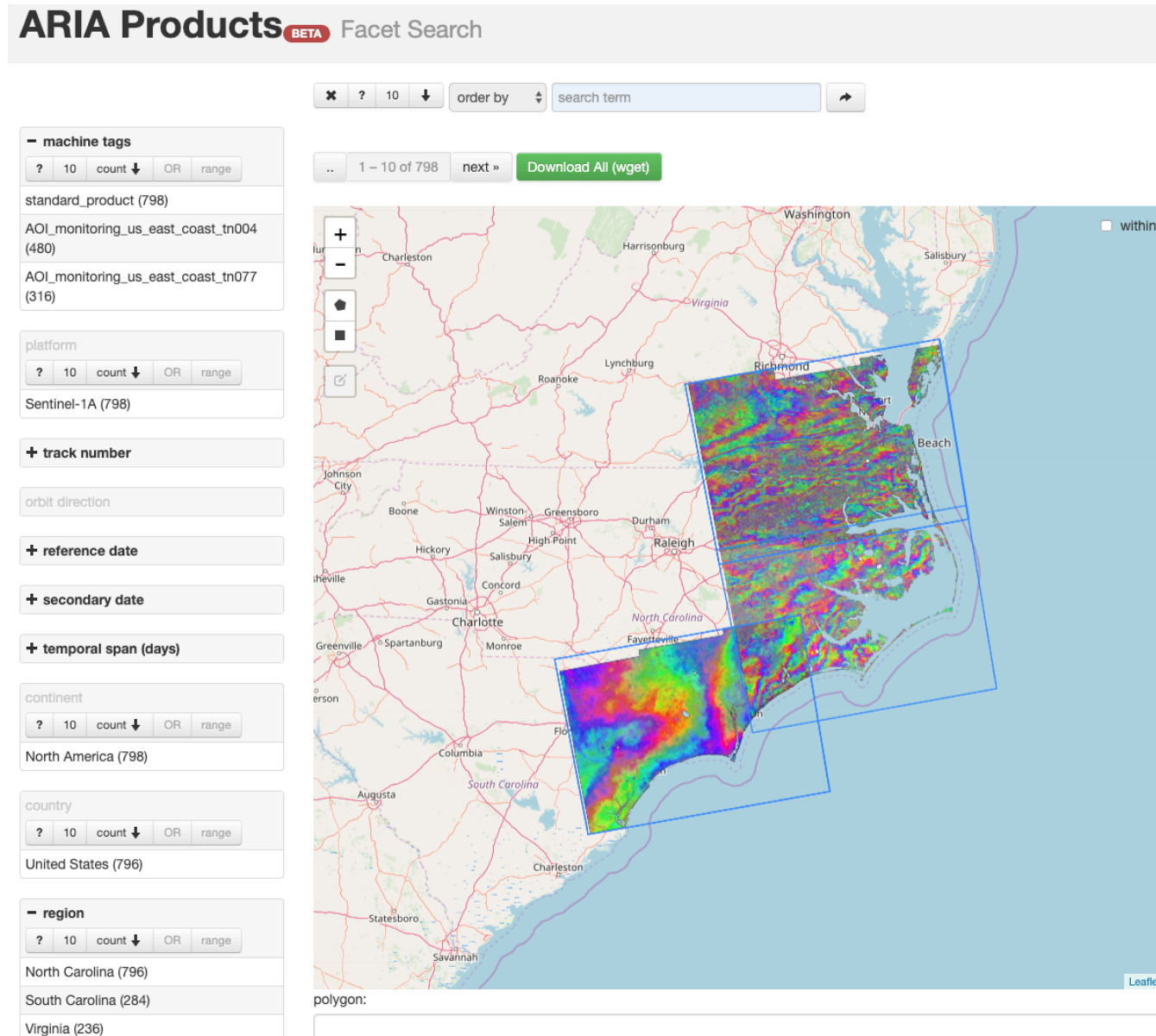
Challenges:

- Decorrelation noise introduced due to vegetation/wetlands
- Super-imposed atmospheric noise from ionosphere/troposphere.
- Superposition of signals (tides, tectonic, GIA, anthropogenic, etc.)



InSAR data and analysis:

- The **Advanced Rapid Imaging and Analysis (ARIA)** Project, a joint effort of California Institute of Technology (Caltech) and the Jet Propulsion Laboratory (JPL), is developing the infrastructure to generate **imaging products in near real-time** that can improve situational awareness for disaster response.
- **ARIA standard products** consists of Sentinel-1 interferograms and coherence along with the required metadata over selected AOIs.
- **ARIA-tools** is an open source software package which provides tools to handle and prepare for time series applications.
- **MintPy** is an InSAR time series package that allows users to carry out SBAS (Small BASeline) time series on InSAR datasets.

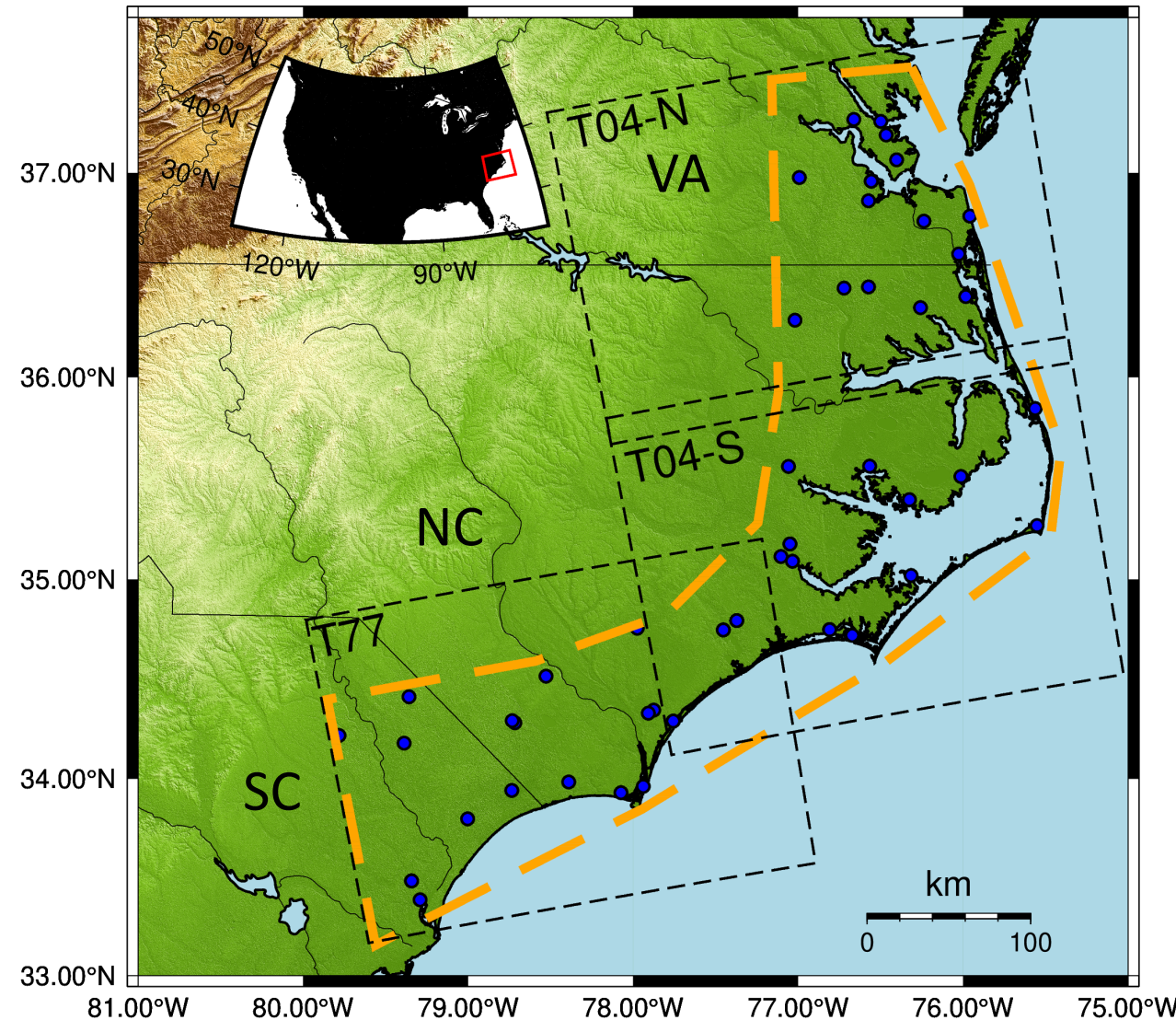


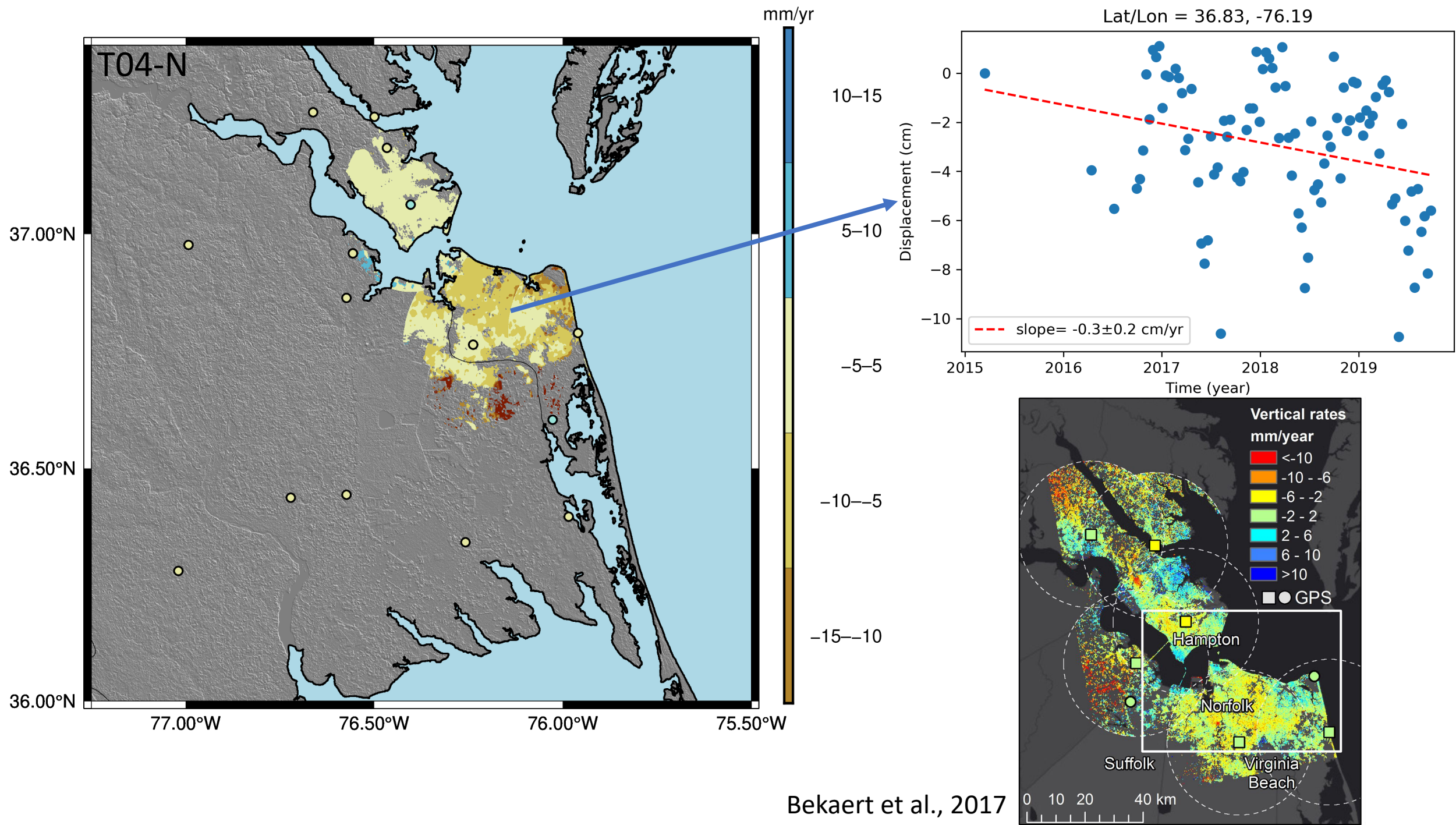
ARIA products are available free of charge at <https://aria-products.jpl.nasa.gov/>

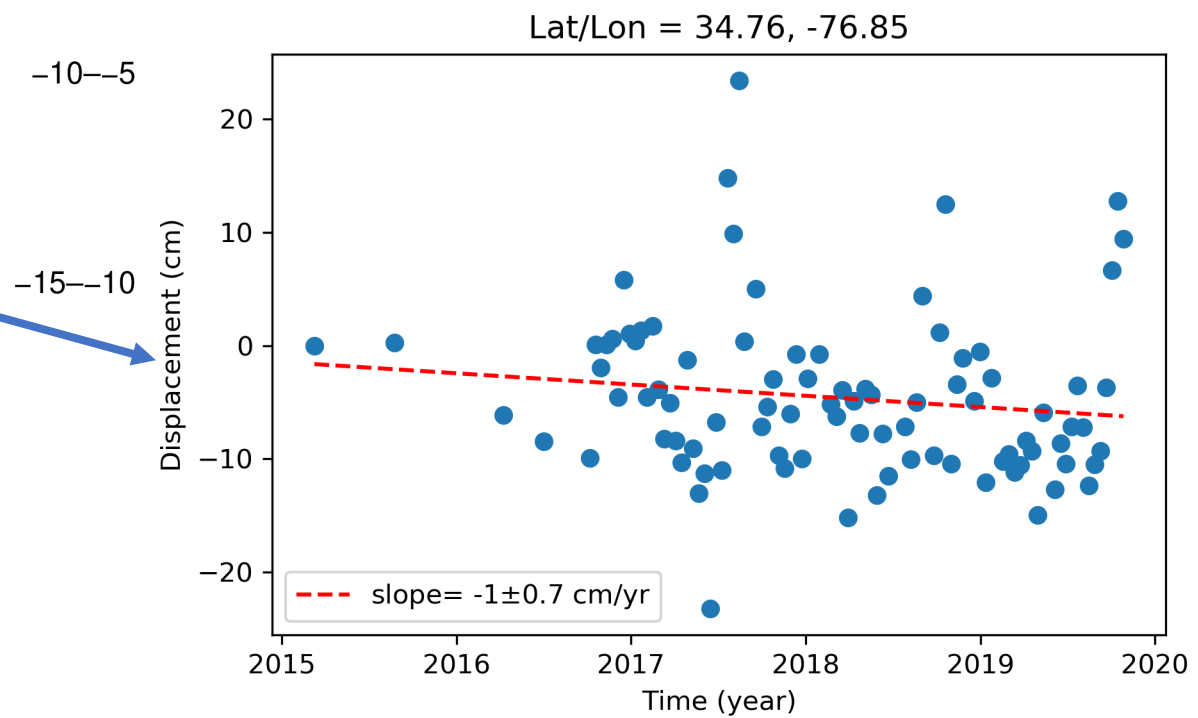
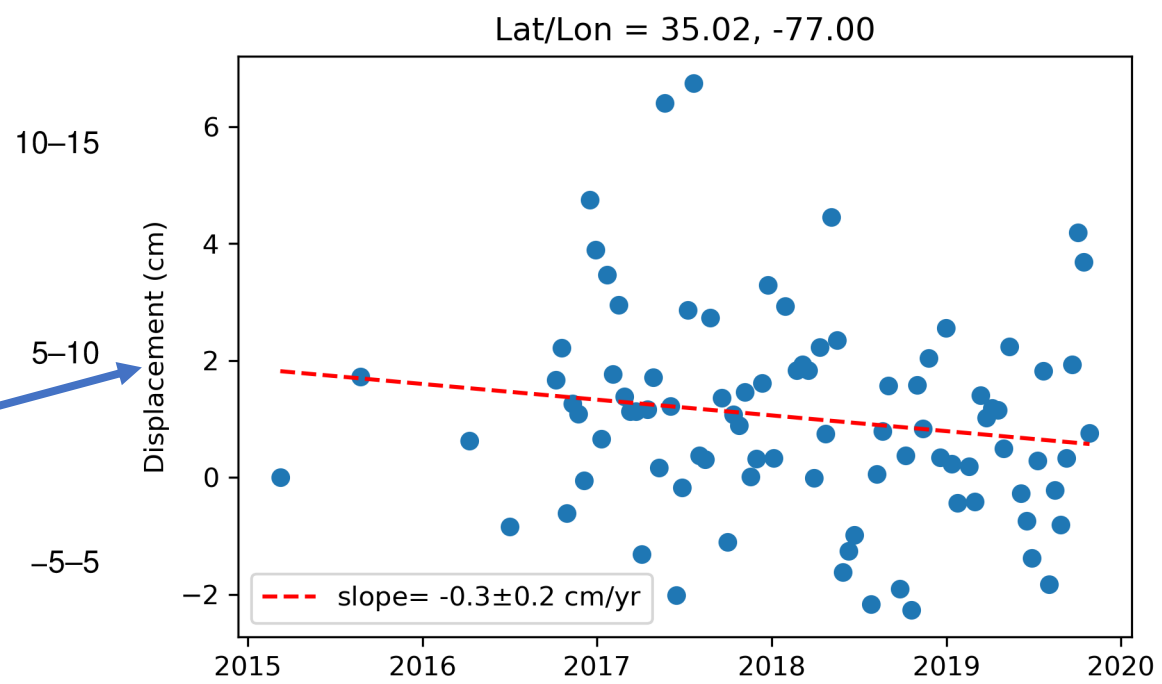
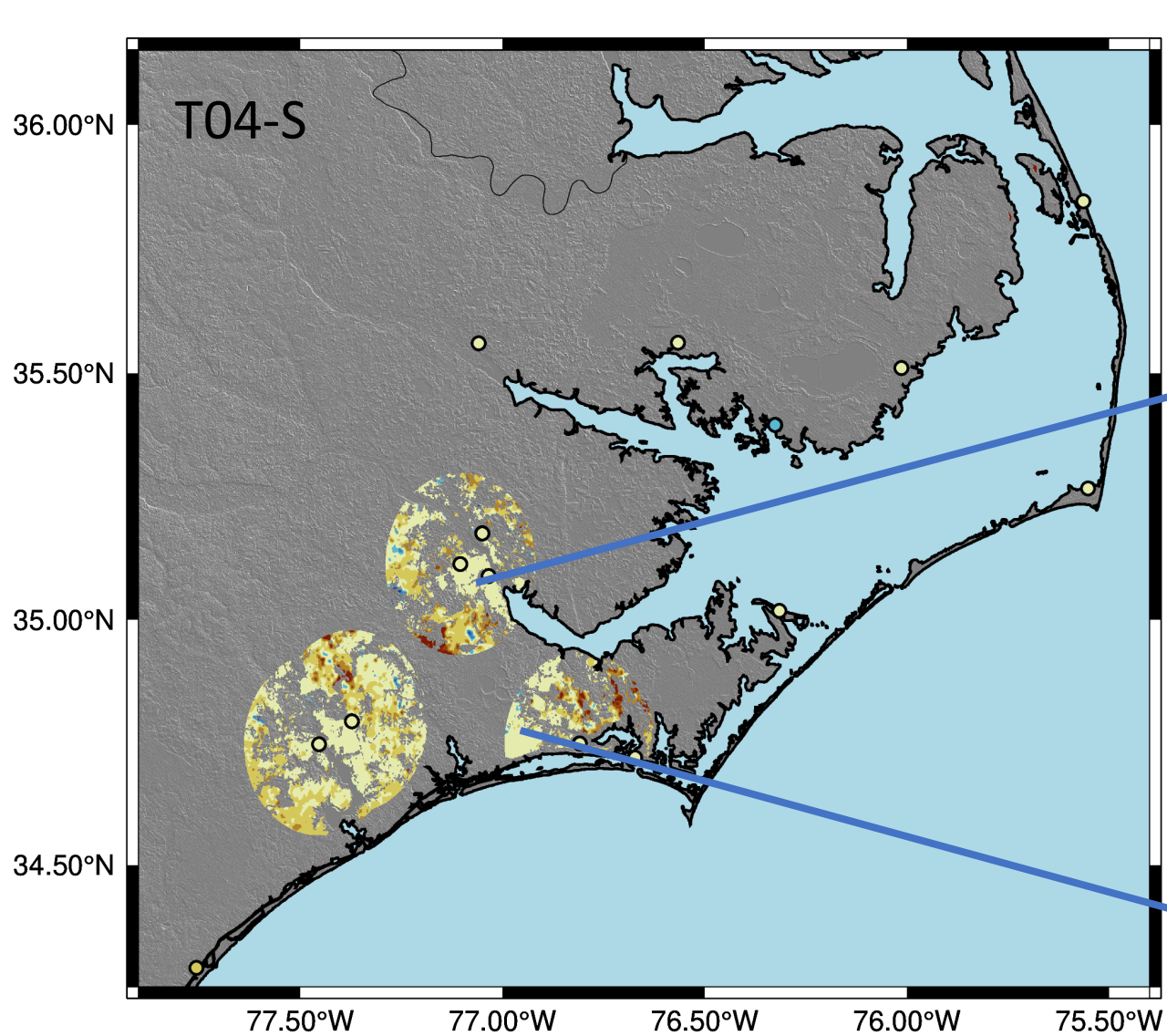
Our area of interest extends a couple hundred kilometers in land from the coast

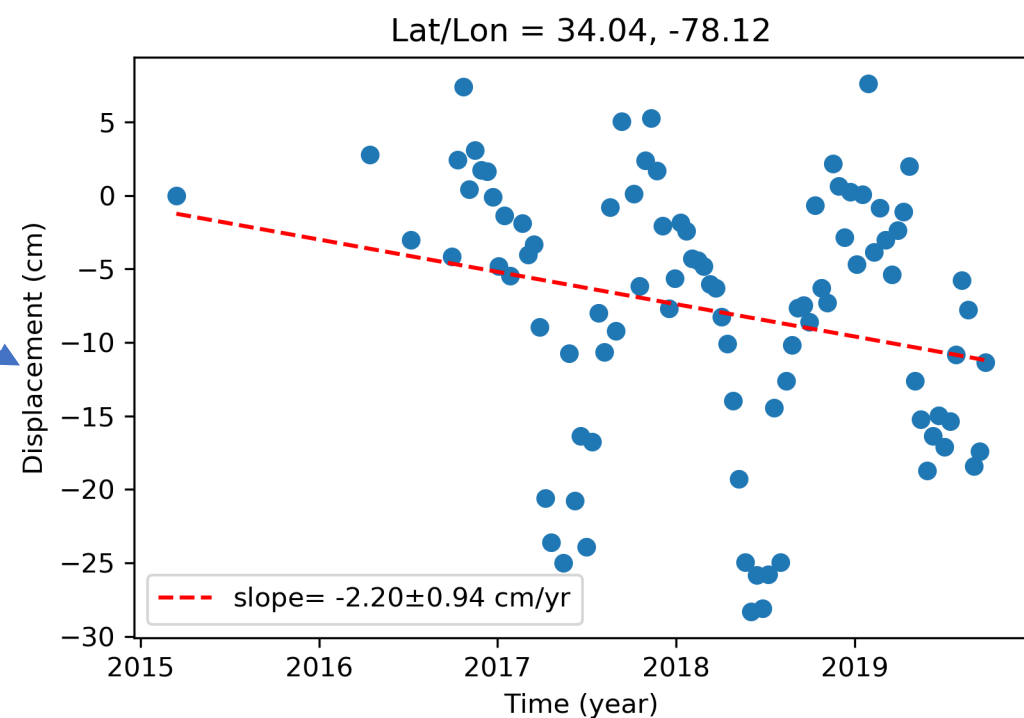
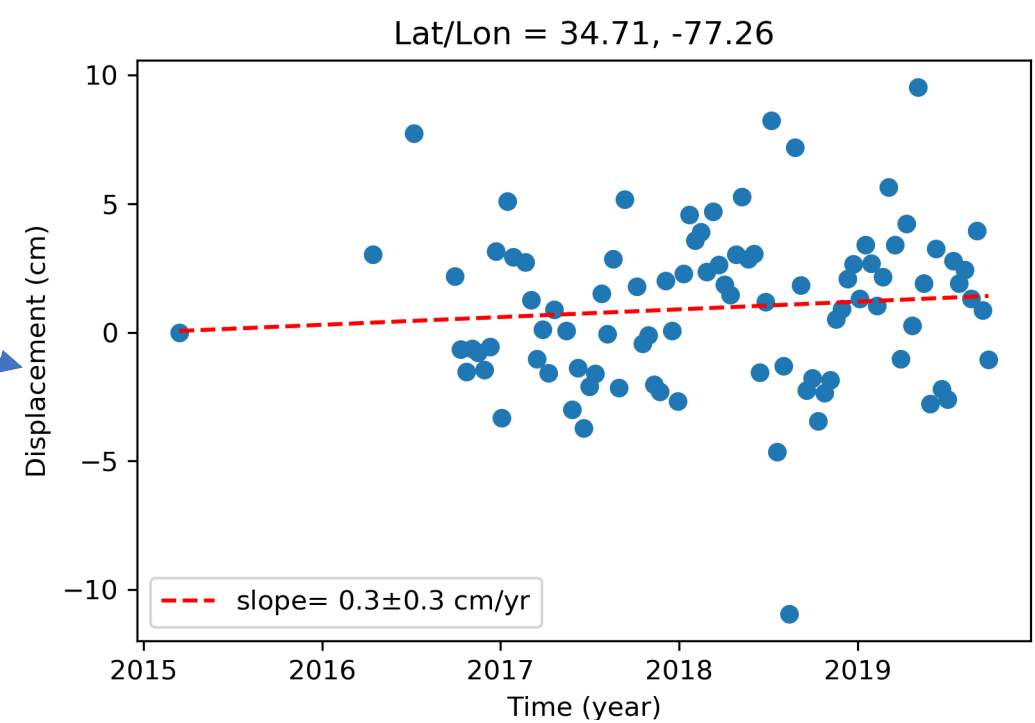
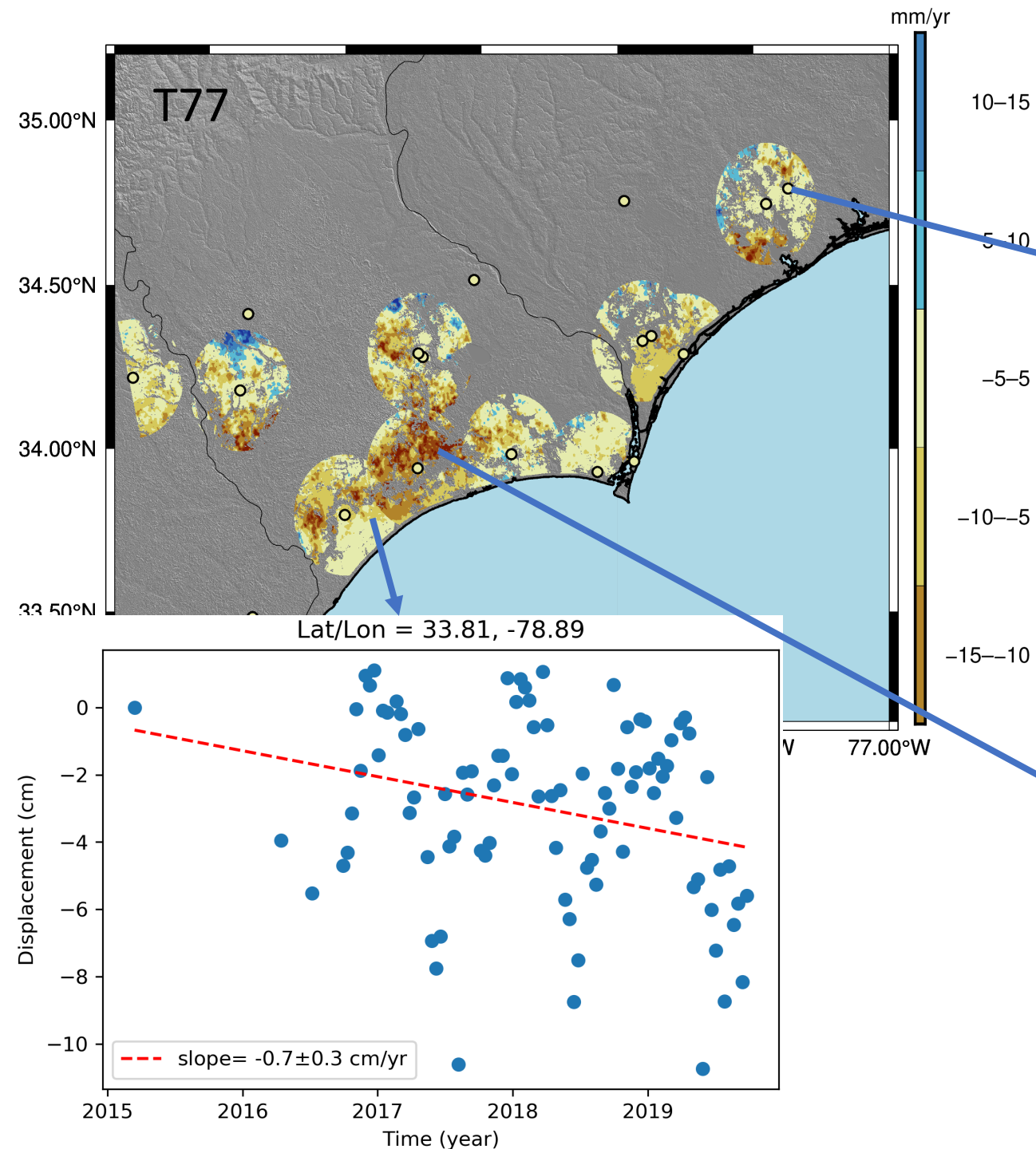
- We **complement InSAR and GNSS**
 - InSAR for short length scales
 - GNSS long length scales
- We use **GNSS stations as reference points** for InSAR and only analyze the **pixels within 20km** distance from the GNSS station.
 - GNSS stations are **rejected in case of low coherence** in the selected pixels.
- **InSAR velocities are projected to vertical** and combined with Up component velocities of GNSS stations.
- Final uncertainties are propagated by taking both InSAR and GNSS uncertainties into account.

$$\sigma_{vertical} = \sqrt{\sigma_{InSAR}^2 + \sigma_{GNSS}^2}$$









Summary

- Geodetic observations from **InSAR and GNSS** can provide measurements of short wavelength deformation **signals** such as subsidence.
 - InSAR is strongly challenged in coastal areas.
- Our results show that **subsidence hot spots** in the east coast is reaching to the order of **cm per year**. Magnitude of subsidence in the east coast has **significant impact on relative sea level** and needs to be taken into account for flood mitigation planning.
- Subsidence has strong **variation in space** and short wavelength subsidence signals can have large magnitudes.
- **InSAR and GNSS** methods can provide key **vertical land motion** information.